



Fire Program Analysis – Preparedness Module

Analysis of Three Fire Event Scenarios, Dry, Wet and All Years

August 22, 2005

Issue: The current process used to prepare a Fire Event Scenario for the Fire Program Analysis – Preparedness Module is not developing a representative fire season for the Fire Planning Unit.

Current Process: The Fire Program Analysis uses a “randomly generated fire season” or “Fire Event Scenario” (FES) as one of the primary inputs to the Initial Response analysis or Preparedness Module as it is commonly called. Currently, a single, probabilistic FES is created through a series of random draws. The current process uses random draws to determine if a fire will occur within a Fire Management Unit on a given day. By fixing the starting number or “seed” the user is able to generate the same number of fires within a FES, enabling repeatable results. The current process for preparing a FES has the potential of providing a poor representation of the fire season for the Fire Planning Unit because there is **one** scenario created using random numbers. The fixed seed is used with a random number table to allow a draw with a known starting point. This FES may not be representative of the possible fires seasons that could be expected within the Fire Planning Unit and that should be included within the Initial Response analysis.

The current process used by FPA-PM to prepare the FES includes fire reports for January 1, 1994 through December 31, 2004 to determine the Preparedness Staffing Season. Then, each day’s weather observations for the entire time period are used to calculate fuel moistures by size class for the National Fire Danger Rating System (NFDRS) fuel model that is defined per Fire Management Unit (ERCx where x represents FMU NFDRS fuel model). These fuel moistures are placed into 6 bins by percentile of occurrence. Bin 1 contains 10 percent of the highest fuel moistures, bins 2 – 5 contain 20 percent each and bin 6 contains 10 percent of the lowest fuel moistures.

This current process of generating the FES may not provide an adequate representation of the modeled fire season for all FPUs. Therefore, the current process was tested and analyzed, and alternative solutions are proposed.

FES Themes: Three different themes or FES’s were developed to explore the potential outcomes from the Initial Response analysis as compared to a single FES. The primary questions being tested is “Is a single draw FES able to consistently provide a representative fire season for the Fire Planning Unit and the corollary question, how likely is a single draw FES to produce an anomalous FES”?

Following are the general descriptions for the three different themes or weather data sets used to prepare three separate FES’s using the current single draw.

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Common to All Three FES's:

The same process as described in the Current Process above was used to determine the Preparedness Staffing Season.¹ Fuel moisture bins used the same process with the exception of the weather data set being truncated to match the Preparedness Staffing Season as shown in Figure 2. This results in no fires being drawn outside of the Preparedness Staffing Season. The specifics regarding each of the three themes are described below.

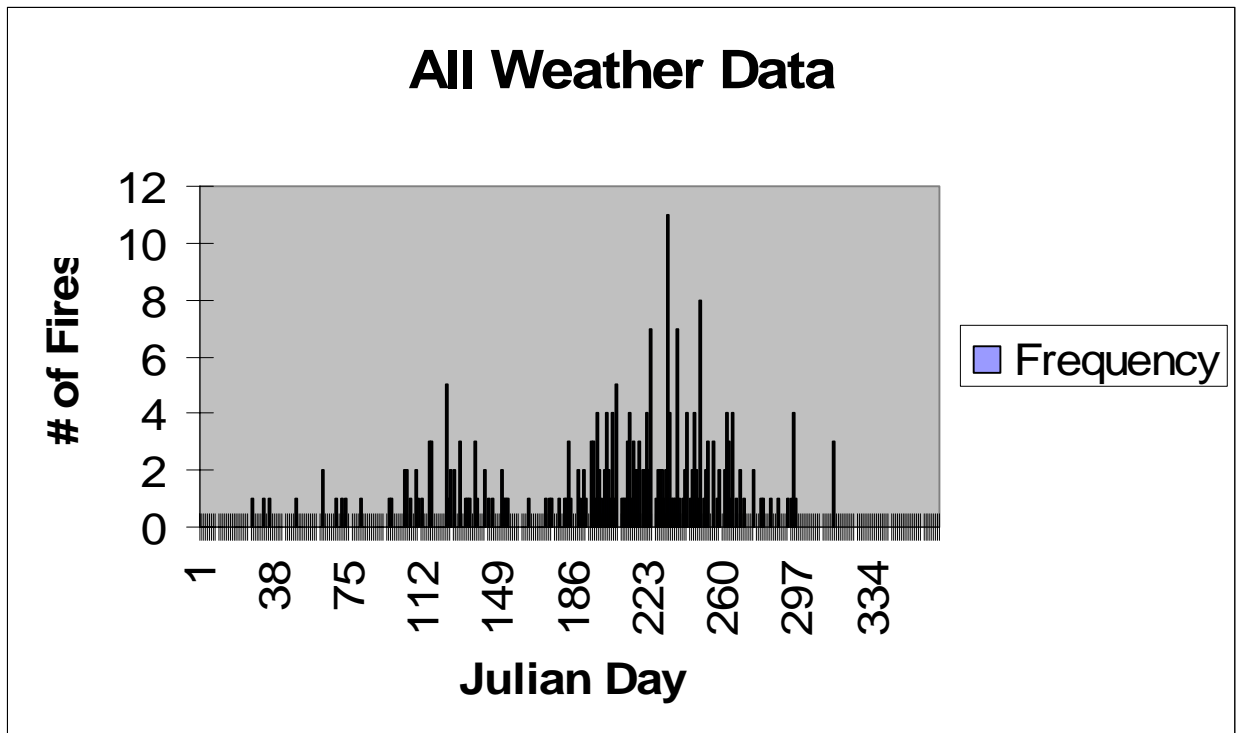


Figure 1

¹ White Paper Topic – Funding Period for Production Personnel - prepared by Lou Ballard, FPA Core Team 2/1/05
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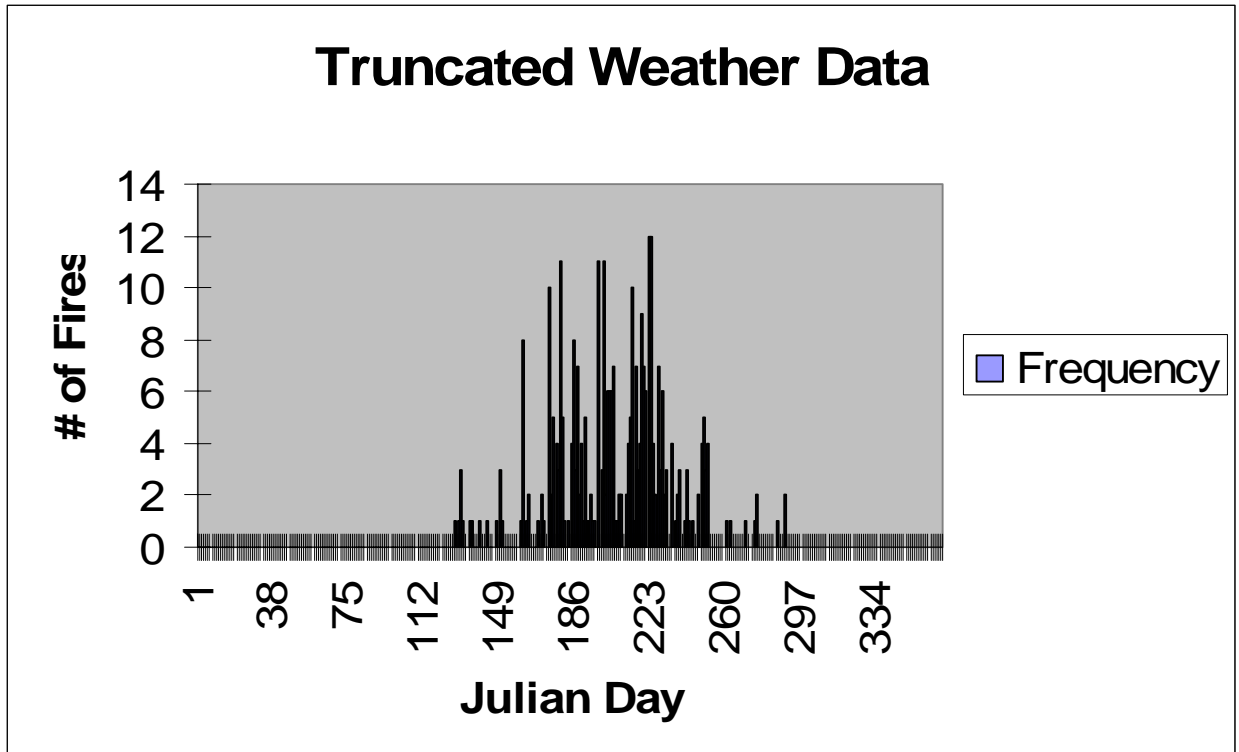


Figure 2

ALL YEARS: For the eleven year period from 1994 through 2004, there are an average annual of 439 fires in PCHA or a total of 4833 fire reports. The FES prepared by PCHA generated 242 fires, using eleven years of weather data within the Preparedness Staffing Season.

WET: Examining weather data and local knowledge, 1993 was selected as the data set to use representing a low fire occurrence work load due to a wet weather year for the Fire Planning Unit. Only the weather data for the Preparedness Staffing Season during the 1993 season was used in the binning process to prepare this FES. PCHA has 124 fire reports for the 1993 within the FPU, the FES generated 83 fires

DRY: After a review of daily weather records coupled with local knowledge, the year of 2000 was used to represent a dry year associated with a high level of initial response workload. The year of 2000 has 575 fire reports for the Fire Planning Unit and the FES generated 372 fires.

CONCLUSION: An analysis was completed for each FES. The reports can be found in the appendix.

Each of the three possible FES's has a significantly different Weighted Acres Managed.

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The drastically different number of fires for each scenario could lead one to conclude that a single random FES does not meet the need of FPA to use an expected FES. The outputs reinforce that current FES generation is deterministic, which means there is some risk that a non-representative FES can be generated for further analysis. Therefore, a stochastic process should be used to prepare many FES's for each FPU to ensure that the range of potential fire seasons is analyzed by FPA-PM.

Below are the Cost Summary Reports from FPA-PM using all three different FES's the difference in WAM for the \$22.5 million is significant when you compare All Years to Wet and All Years to Dry or Wet to Dry.

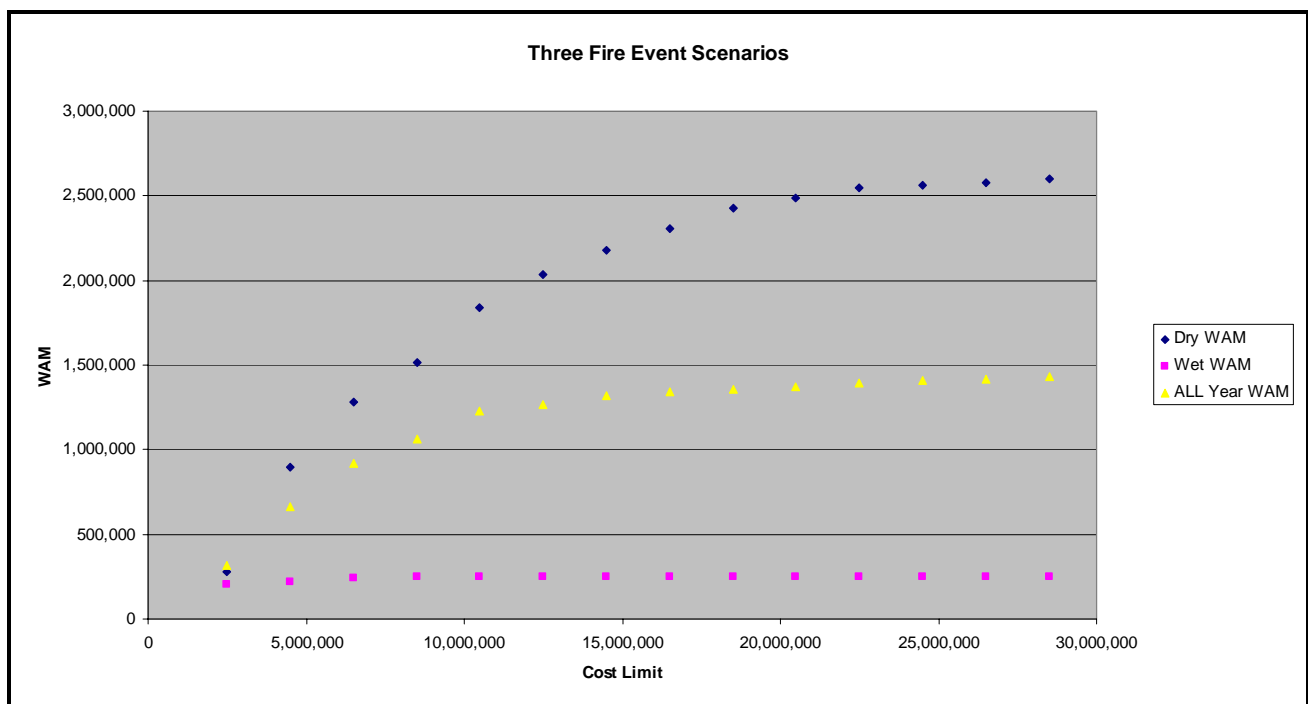


Figure 3

Alternatives:

A. No Action, As Is

This alternative would result in no change to our current processes for preparing Fire Event Scenario and optimization.

Plus: Would result in no additional development cost.

Minus: Continues with a deterministic process for preparing Fire Event Scenarios, for which the development team has already been criticized.

User difficulty in explaining results of Fire Event Scenario, and some user dissatisfaction. Single Fire Event Scenario that may not represent the Fire Planning Units workload.

B. Stochastic Optimization Process

This alternative would develop 50 to 200 Fire Event Scenarios', the optimization routine would optimize across all FES's at the same time, producing a Cost Effective frontier for the FPU. Stochastic optimization will provide only one optimal solution per cost constraint as identified within analysis parameters in FPA-PM. This alternative would utilize a truncated weather data set to determine the time of year that fires could be drawn from as seen in Figure 2 compared to Figure 1.

The full impact upon the optimization routine is unknown at this time however it is anticipated that run times may increase significantly as compared to alternative A.

Plus: Would provide a much more defensible process of preparing Fire Event Scenarios and optimal Cost Effective frontier.
Users could easily explain the results of Fire Event Scenarios and FPA-PM outcomes to Line Officers and other stakeholders.
Analyze the full range of possible "fire seasons".

Minus: Increase in development cost.
Delay product delivery date.
Significantly increase optimization run time.

C. Stochastic Fire Event Scenario without Stochastic optimization

This alternative would stochastically develop 50 to 200 Fire Event Scenarios within the Historic Analysis or PCHA. The FPA Core Team on behalf of the Steering Committee will identify attributes of a fire event that will serve as a criteria for applying weights in order to identify the "most representative" Fire Event Scenario that will be optimized. This alternative will have the computer code written to satisfy or allow the enabling of Alternative B if so desired.

Impact upon the optimization routine is estimated to be the same as alternative A.

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Plus: Users could easily explain the results of Fire Event Scenarios and FPA-PM outcomes to Line Officers and other stakeholders.
Computer Code for preparing Fire Event Scenarios for input to stochastic optimization would be complete.
Reduce training time and material over the long term.
Less cost than alternative B.
Provides a process for evaluating a Fire Event Scenario that will be used as input for the optimization routine, utilizes weighted criteria.
No impact on the optimization routine.

Minus: Increase development cost (\$24,950.).
Increase time for lesson plan modifications.
Less defensible overall process than alternative B.

Recommendation: Alternative C: Based upon the original design recommendations from Dr. Mark Finney and others, two of the three proposed alternatives of modifying our current process for “Preparing a Fire Event Scenario” should be made. The recommended interim approach represented here is to enhance PCHA to randomly generate a large number of Scenarios (perhaps 100 or more) and then select a “representative” scenario based on a number of evaluation factors. It should be noted that this is not a stochastic approach, although it does set the stage for future stochastic outputs from PCHA. A plus with Alternative C over B is Alternative B can be implemented when ready at a low to no cost option as the code for the Stochastic Process will be written in order to develop Alternative C. FPA-PM is not ready for Alternative B due to the unknown impacts upon the optimization routine. Alternative C is a step between our current As Is process and Alternative B, Stochastic.

Specifically, the following is proposed:

1. PCHA will generate and store 100 Fire Event Scenarios. The number 100 will be an internal parameter which can be easily changed in future releases.
2. PCHA will rank the Fire Event Scenarios based on the following criteria (each with a weight that will be defined at a later date:
 - a. Number of fires per year:
 - b. Average Rate-of-Spread
 - c. Percent of Fire Days Simultaneous
 - d. Average Fire Intensity Level
 - e. Others as needed...

All weights will be internal parameters which can be easily changed in future releases.

3. Determine, and report in the XML, the 50th percentile Scenario from the above ranking. (Note: the 50th percentile is just used for demonstration; it will be up to the steering committee to determine the percentile that the FPU's should plan for).

Additionally, since 100 Fire Event Scenarios are being prepared, code shall be prepared to export all 100 in a single XML file in the event that FPA-PM is enhanced to accept a stochastic representation in future releases.

Steering Committee Decision: Following a call with Dr. Mark Finney from the Fire Behavior Project, Rocky Mountain Research Station, USDA Forest Service a decision was made to proceed with Alternative C. It was acknowledged by Dr. Finney that Alternative B was the desirable choice but recognized that Alternative C is a step along the path toward Alternative B.

A process to develop test scenarios for identifying the evaluation criteria with associated weights to be used for identifying the Fire Event Scenario to pass into the optimization routine is as follows.

- Two Fire Planning Units will be used. A separate FPU Team will be established for each so that the field FPU Team is not impacted.
- 100 Fire Event Scenarios will be randomly generated for each FPU. Attributes for potential weighting (e.g. number of fires) will be determined for each.
- Each Fire Event Scenario will be run through FPA-PM in order to determine Weighted Acres Managed. Following the completion of all runs, a query (report) will return the WAM for all runs.
- Statistical correlation between WAM and the potential weighting factors will be performed, in order to determine the relative strength of the relationships. These correlation factors will then be used to guide the development of the weights which will be deployed in PCHA.

Appendix A

Cost Limit (\$)	WAM	Water Tender	Engine	Dozer/Tractor Plow	Crew	Air Tanker	Heli	Fixed Wing	Smoke Jumper	Contained Fires	Uncontained Fires
2,500,000	319,591	0	0	0	0	0	0	0	0	27	150
4,500,000	665,508	0	10	0	1	0	0	0	0	80	97
6,500,000	921,837	0	19	0	1	0	0	0	0	104	73
8,500,000	1,064,339	0	20	0	4	0	1	0	0	125	52
10,500,000	1,229,879	0	20	2	7	0	2	0	0	135	42
12,500,000	1,265,541	0	21	2	11	2	2	0	0	136	41
14,500,000	1,317,230	0	29	2	14	2	2	0	0	140	37
16,500,000	1,342,978	0	34	2	16	2	2	0	0	142	35
18,500,000	1,354,002	0	36	2	22	3	2	0	0	143	34
20,500,000	1,373,197	0	37	2	25	5	2	0	0	142	35
22,500,000	1,393,392	0	41	2	22	7	2	0	0	151	26
24,500,000	1,407,177	0	37	2	27	8	2	2	2	148	29
26,500,000	1,416,716	0	44	2	24	8	2	2	2	152	25
28,500,000	1,434,781	0	44	2	29	9	2	3	3	156	21

All Years Event Summary

Wet Year Event Summary

Cost Limit (\$)	WAM	Water Tender	Engine	Dozer/Tractor Plow	Crew	Air Tanker	Heli	Fixed Wing	Smoke Jumper	Contained Fires	Uncontained Fires
2,500,000	200,816	0	11	0	0	0	0	0	0	52	26
4,500,000	220,768	0	18	0	0	0	1	0	0	60	18
6,500,000	240,297	0	23	0	0	0	2	0	0	76	2
8,500,000	245,003	0	30	0	0	1	2	0	0	78	0
10,500,000	248,056	0	36	0	5	1	2	0	0	78	0
12,500,000	248,357	0	44	0	5	1	2	0	0	78	0
14,500,000	248,454	0	44	0	15	1	2	0	0	78	0
16,500,000	248,469	0	44	0	15	3	2	1	1	78	0
18,500,000	248,527	0	44	0	15	6	2	0	0	78	0
20,500,000	248,549	0	41	0	18	6	3	2	2	78	0
22,500,000	248,599	0	44	0	18	8	3	2	2	78	0
24,500,000	248,599	0	44	0	18	8	3	2	2	78	0
26,500,000	248,599	0	44	0	18	8	3	2	2	78	0
28,500,000	248,599	0	44	0	18	8	3	2	2	78	0

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Dry Year Event Summary

Cost Limit (\$)	WAM	Water Tender	Engine	Dozer/Tractor Plow	Crew	Air Tanker	Heli	Fixed Wing	Smoke Jumper	Contained Fires	Uncontained Fires
2,500,000	280,446	0	11	0	0	0	0	0	0	58	259
4,500,000	898,050	0	9	2	10	1	0	0	0	113	204
6,500,000	1,283,173	0	19	0	13	1	0	0	0	96	221
8,500,000	1,514,427	0	27	0	13	1	0	0	0	107	210
10,500,000	1,841,217	0	31	2	18	1	0	0	0	123	194
12,500,000	2,038,920	0	41	2	18	1	0	0	0	152	165
14,500,000	2,177,063	0	41	2	18	1	2	0	0	189	128
16,500,000	2,305,174	0	41	3	25	1	3	0	0	197	120
18,500,000	2,425,438	0	44	2	25	1	4	0	0	236	81
20,500,000	2,488,793	0	44	2	25	3	6	0	0	239	78
22,500,000	2,547,675	0	44	3	25	4	6	1	1	242	75
24,500,000	2,563,602	0	44	2	25	6	6	3	3	259	58
26,500,000	2,579,965	0	44	2	25	5	6	5	5	258	59
28,500,000	2,596,976	0	44	3	27	9	6	5	5	274	43

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